# 8.0 Black Rock Alternative Effects

The Black Rock alternative would have both beneficial and adverse economic, social, environmental, and cultural effects. Some of these effects could be expressed in monetary terms, while others could be expressed qualitatively. While no indepth consideration of potential effects has been made at this time, this chapter briefly discusses some potential effects that could be attributed to the construction and operation of the Black Rock alternative. These potential effects, and others, will be addressed if the Storage Study proceeds. The initial observations offered here would likely change considerably as indepth analyses were performed.

## 8.1 Effects of Exchange Water in the Yakima River Basin

Exchange water in the Yakima River basin would serve three major purposes: instream flows, irrigation, and municipal water supplies.

### 8.1.1 Instream Flows

#### 8.1.1.1 Introduction

One objective of the Storage Study is to assess restoring flow conditions in the Yakima River basin to some semblance of the natural (unregulated) hydrograph. This largely applies to the main stem Yakima, Cle Elum, Naches, and Tieton River reaches downstream from Keechelus Lake, Cle Elum Lake, Bumping Lake, and Rimrock Lake to the mouth of the Yakima River.

Stream ecologists have found that natural hydrologic variability is necessary to maintain a healthy river ecosystem (Richter, Baumgartner, Wigington and Braun, 1997) [17]. The underlying principle is that if some semblance of the natural hydrograph were achieved, then the river ecosystem would remain healthy, maintaining some normative level of the physical and biological processes conducive to a viable fishery resource.

For this Assessment, the objective is to investigate how the Black Rock alternative water exchange might result in modifications to Yakima Project operations so the flow regime of the Yakima and Naches Rivers would have some semblance of the natural (unregulated) hydrograph.

#### 8.1.1.2 Methodology

For comparative purposes, the following three flow scenarios were examined for four main stem reaches of the Yakima and Naches Rivers:

- The unregulated scenario represents an estimated natural pre-Yakima Project stream regime unimpeded by reservoir impoundments or by diversions.

- The current operation scenario represents the current stream regime as managed by Yakima Project's present operations.
- The Black Rock scenario represents a possible stream regime through modification of Yakima Project operations using water obtained through the Black Rock alternative exchange with the Roza and Sunnyside Divisions. This scenario is based on the availability of 810,400 acre-feet of exchange water.

Reclamation gauging stations define the four stream reaches as follows, and figure 8-1 shows their general locations:

- The Easton gauge is located in the upper Yakima River downstream from Easton Diversion Dam at RM 202.0 (Easton reach).
- The Cle Elum gauge is located on the Yakima River near the city of Cle Elum at RM 183.1 (Cle Elum reach).
- The Parker gauge is located immediately downstream from Sunnyside Diversion Dam on the Yakima River at RM 103.7 (Wapato reach).
- The Naches River gauge near the city of Naches is located at RM 16.8 (Naches reach).

The evaluation conducted by Reclamation biologists and hydrologists includes use of results generated from the Yakima Project RiverWare (Yak-RW) model, which is a daily time step reservoir and river operation computer model of the Yakima Project created with the RiverWare software.[7] The Yak-RW model produced results for each scenario evaluated with the Indicators of Hydrologic Alteration software.[8] The Indicators of Hydrologic Alteration software outputs 33 hydrologic parameters that describe how a particular flow regime of a project operation compares to the natural (unregulated) hydrograph.

The Yak-RW model generated hydrographs shown in this Summary Report (figures 8-2, 8-3, 8-4, and 8-5) represent the median monthly flows for water years 1981 through 2003. Hydrographs for the unregulated scenario include vertical green lines representing the 25th percentile (top), 50th percentile (middle), and 75th percentile (bottom) of the monthly flows. This is an attempt to define a more natural (unregulated) hydrograph range of flow based on an acceptable variation around the median flow. Using the unregulated scenario in figure 8-2 as an example, the vertical green line for mid-October can be read as follows:

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[7] The RiverWare software is a river basin simulation tool developed at the Center for Advanced Decision Support for Water and Environmental Systems at the University of Colorado in cooperation with Reclamation and Tennessee Valley Authority. The Center's website, http://cadswes.colorado.edu/riverware, provides supporting documents on the RiverWare software for interested users.

[8] The Nature Conservancy, in conjunction with Smythe Scientific Software (http://www.smythescisoft.com/smythe), developed the Indicators of Hydrologic Alteration software. The Nature Conservancy's website (http://www.freshwaters.org/tools) provides a download of the software and supporting documents for interested users.

- top of vertical line = 25 percent of the October flows were equal to or greater than 600 cfs.
- middle of vertical line = 50 percent of the October flows were equal to or greater than 400 cfs.
- bottom of vertical line = 75 percent of the October flows were equal to or greater than 200 cfs.

The evaluation relates river conditions for spring Chinook salmon and steelhead where appropriate. The underlying premise is that more natural flows are desirable and beneficial to salmonid productivity, abundance, and diversity. This discussion compares and contrasts the key findings among the current operation, Black Rock, and unregulated scenarios.

The findings to date are based solely on preliminary analysis of the hydrographs as related to the unregulated flow condition. The actual benefit to the fishery would need to be determined from the fish habitat analysis.

For the most part, the Black Rock scenario would make little improvement relative to the current operation scenario for the spring Chinook salmon spawning life stage in the upper Yakima River. This is because the current flip-flop reservoir operation was designed to maximize the benefit to the spring Chinook salmon spawning and incubation life stages.

The flip-flop reservoir operation is coordinated with the beginning of spring Chinook salmon spawning about mid-September in the upper Yakima River system. Irrigation releases from Cle Elum Lake are decreased and releases from Rimrock Lake are increased to meet irrigation demands downstream from the Naches River confluence. The decrease in Cle Elum Lake releases encourages spawning in the main river channels rather than along the stream margins. This operation allows more reservoir inflow to be stored in Cle Elum Lake later in the year rather than needing to be released to cover redds that otherwise would have been deposited along the stream margins.

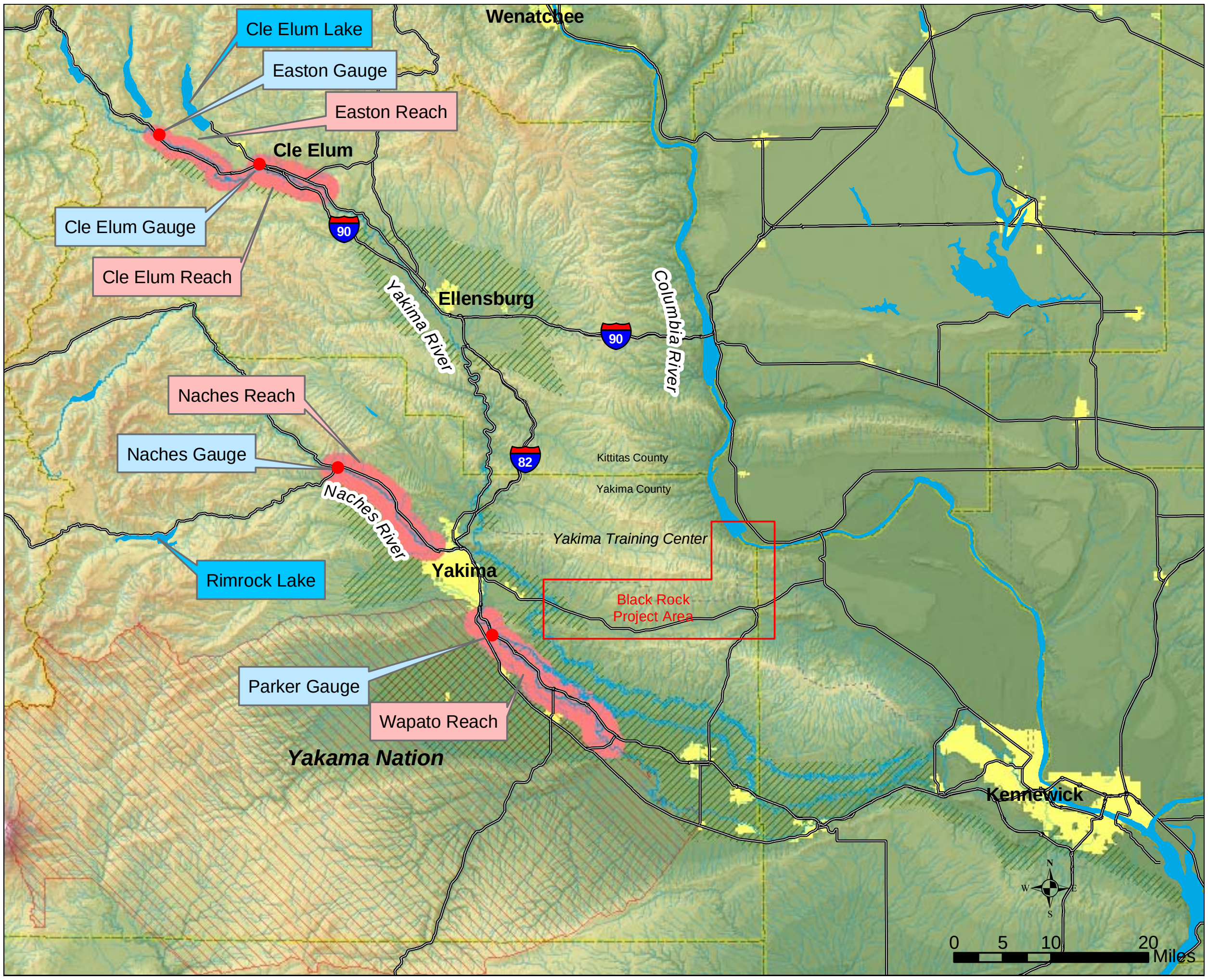


Figure 8-1. The four identified stream reaches and related Reclamation gauge locations

### 8.1.1.3 Easton Reach

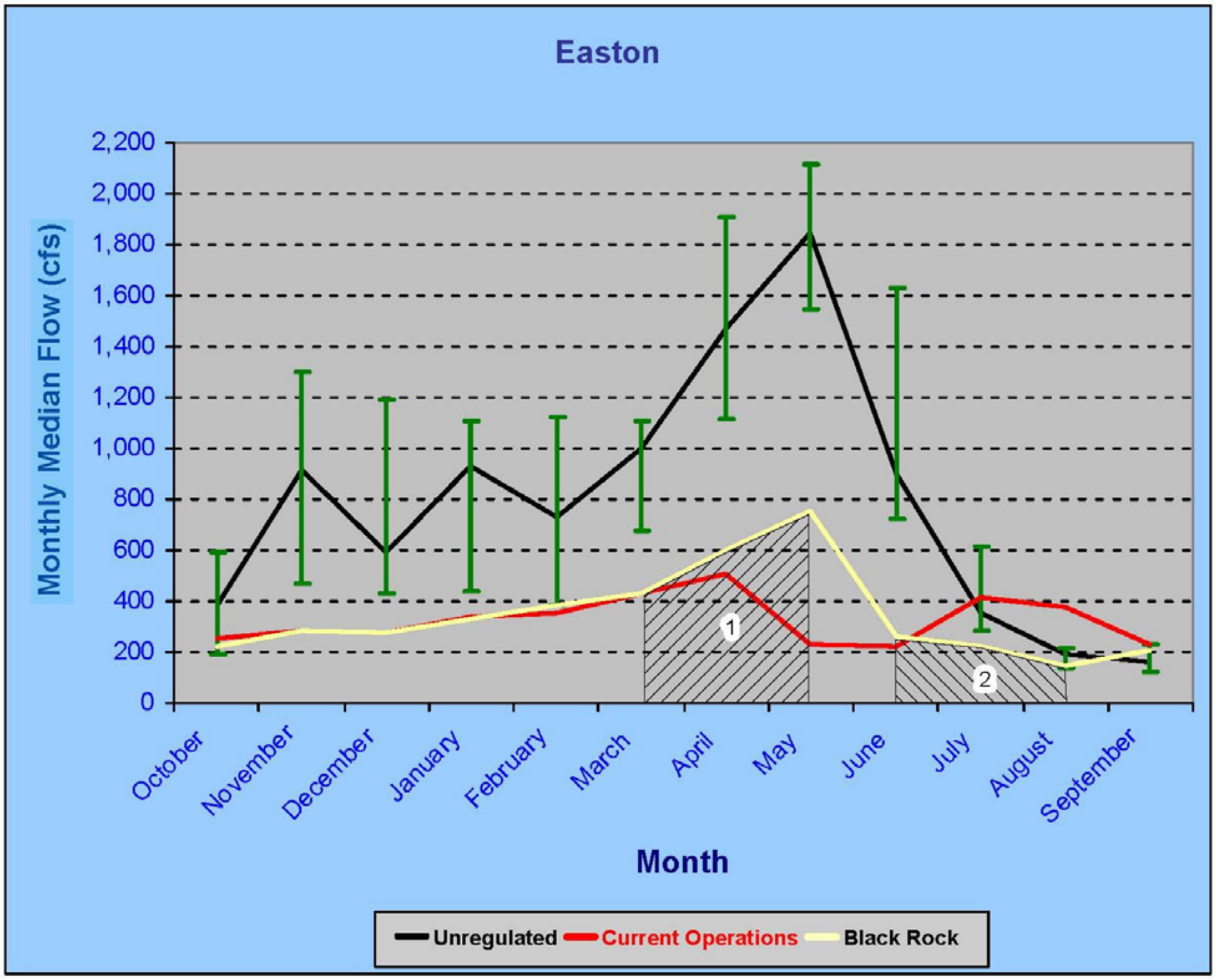


Figure 8-2. Comparison of estimated median monthly Easton reach flows under the three scenarios (based on the 1981-2003 period of record)

The following discussion describes the numeric indicators shown on figure 8-2.

1. The spring flow regime of the Black Rock scenario would represent a more natural (unregulated) hydrograph with peak runoff flows occurring in May at an average 750-cfs flow, instead of occurring in April at an average of about a 500-cfs flow. Also, the Black Rock scenario would provide nearly 100 cfs more in average April flow (597 cfs) compared to the current operation scenario (509 cfs). These two changes in the spring hydrograph would benefit all salmonid smolt outmigrants.

   The Black Rock scenario would further benefit spring Chinook salmon and steelhead smolt outmigrants and fry colonization life stages if a more gradual decrease in flows from May to June could be achieved. This change would reduce the risk of stranding emergent fry in side channels and decreasing rearing habitat, while increasing flows to aid late migrating smolts. It would also reduce the risk of dewatering early spawned steelhead redds. Similar to spring

Chinook salmon, steelhead spawn in shallow water along the stream margins and would use small side channels more than spring Chinook salmon.

2. The current upward trend in river flow from June through August would be eliminated with the Black Rock scenario, providing a more normative hydrograph during the summer rearing life stage.

### 8.1.1.4 Cle Elum Reach

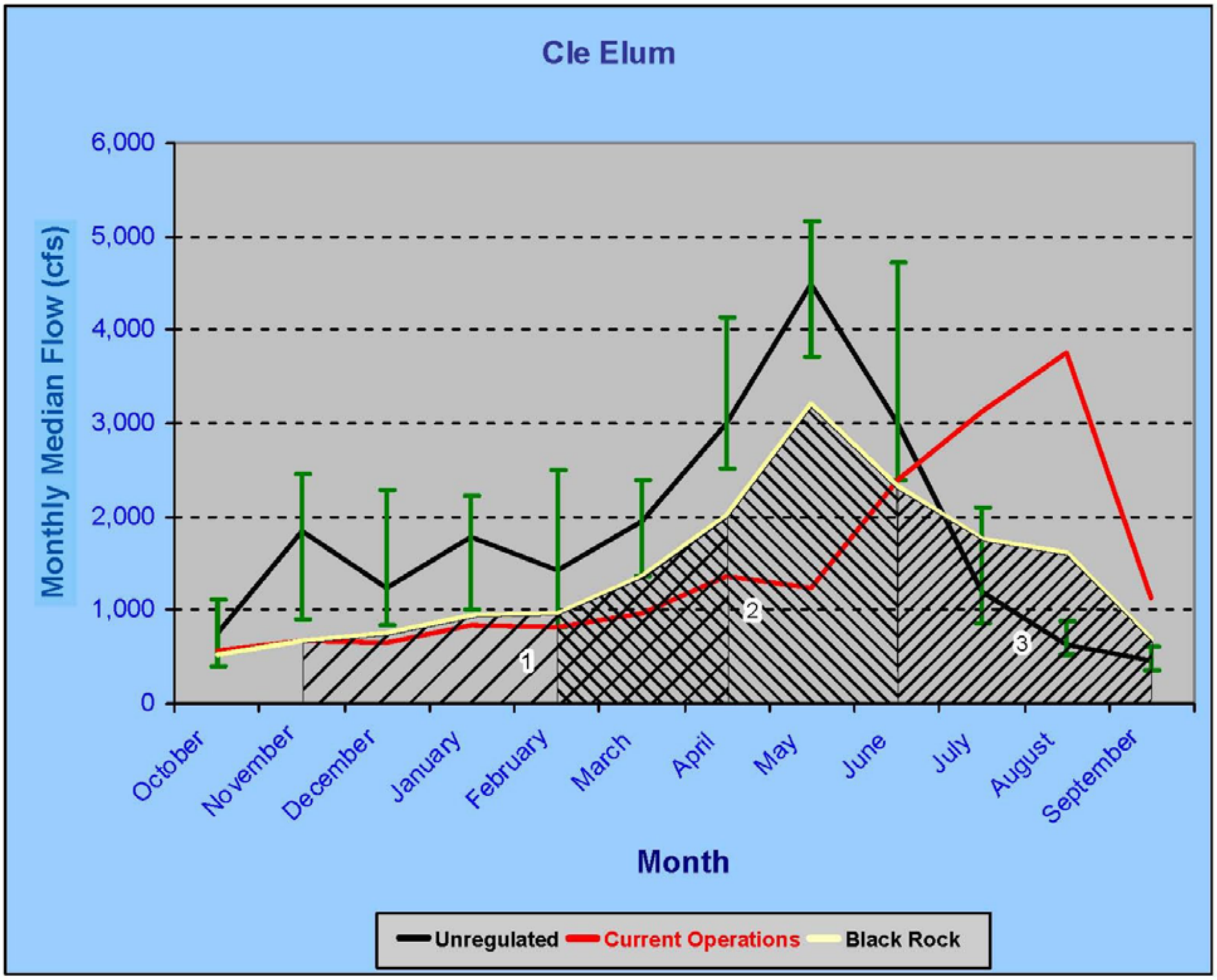


Figure 8-3. Comparison of estimated median monthly Cle Elum reach flows under the three scenarios (based on the 1981-2003 period of record)

The following discussion describes the numeric indicators shown on figure 8-3.

1. The Black Rock scenario would provide a slight improvement in winter rearing flows. Biologically, the potential exists for improved overwintering conditions by the creation of more side channel and backwater habitat, as well as increased interface of the water's edge with the riparian zone (i.e. overhanging vegetation and large woody debris along the stream margin).

   The Black Rock scenario would also provide some improvement in spring Chinook salmon egg incubation flows, especially with increased March and April flows. These improved flows would carry forward into the spring Chinook salmon fry colonization period (March through May) where the low range flows (≤25$^{th}$ percentile) would occur less frequently and middle range flows (>25$^{th}$ to <75$^{th}$ percentile) would occur more frequently than under the current operation scenario. This should improve emergent fry access to preferred side channel and backwater habitats, which are limited in most of the Yakima River downstream from the Cle Elum River. This is due, in part, to the lack of higher spring flows. With a more natural (unregulated) hydrograph, the side channels and backwater habitat would be watered up and provide excellent nursery areas for newly hatched spring Chinook salmonid fry. Emergent fry seek refuge in these quiet, shallow areas, which often provide good instream and overhead cover until the fry are large enough to safely rear in the main stem channels.

2. Smolt outmigrant flows with the Black Rock scenario would be much improved both in terms of timing (more closely following the natural hydrograph) and magnitude of peak flows (table 8-1).

Table 8-1. Cle Elum reach comparison of smolt out migration flows

| | Black Rock Scenario | Current Operation Scenario |
|---|---|---|
| April flows | 2,000 cfs | 1,350 cfs |
| May flows | 3,200 cfs | 1,250 cfs |
| June flows | 2,300 cfs | 2,400 cfs |

Potentially, the improved flows should increase smolt-to-smolt survival by reducing smolt travel time and exposure to predators, plus reducing residence time in the lower river in May and June when water quality typically begins to deteriorate (primarily because of sublethal to lethal water temperatures).

3. The Black Rock scenario would provide a more natural (unregulated) hydrograph for summer rearing spring Chinook salmon and steelhead, especially in July and August for the high flow ranges and, to a lesser degree, in September. The hydrograph, in general, would decline throughout the summer, which is comparable to the unregulated scenario; whereas under the current operation scenario, July and August flows would be significantly higher to meet downstream irrigation demand.

   The near elimination of flip-flop reservoir operation under the Black Rock scenario would be a major benefit to summer rearing salmonids by providing a more normative adjustment to habitat changes (i.e., flows in the main stem and side channels would decrease according to the natural flow pattern that fish have adapted to). Steelhead fry, in particular, are most sensitive to flip-flop operation because of their dependence on quiet, shallow rearing habitat, which is most vulnerable to flow changes.

### 8.1.1.5 Wapato Reach

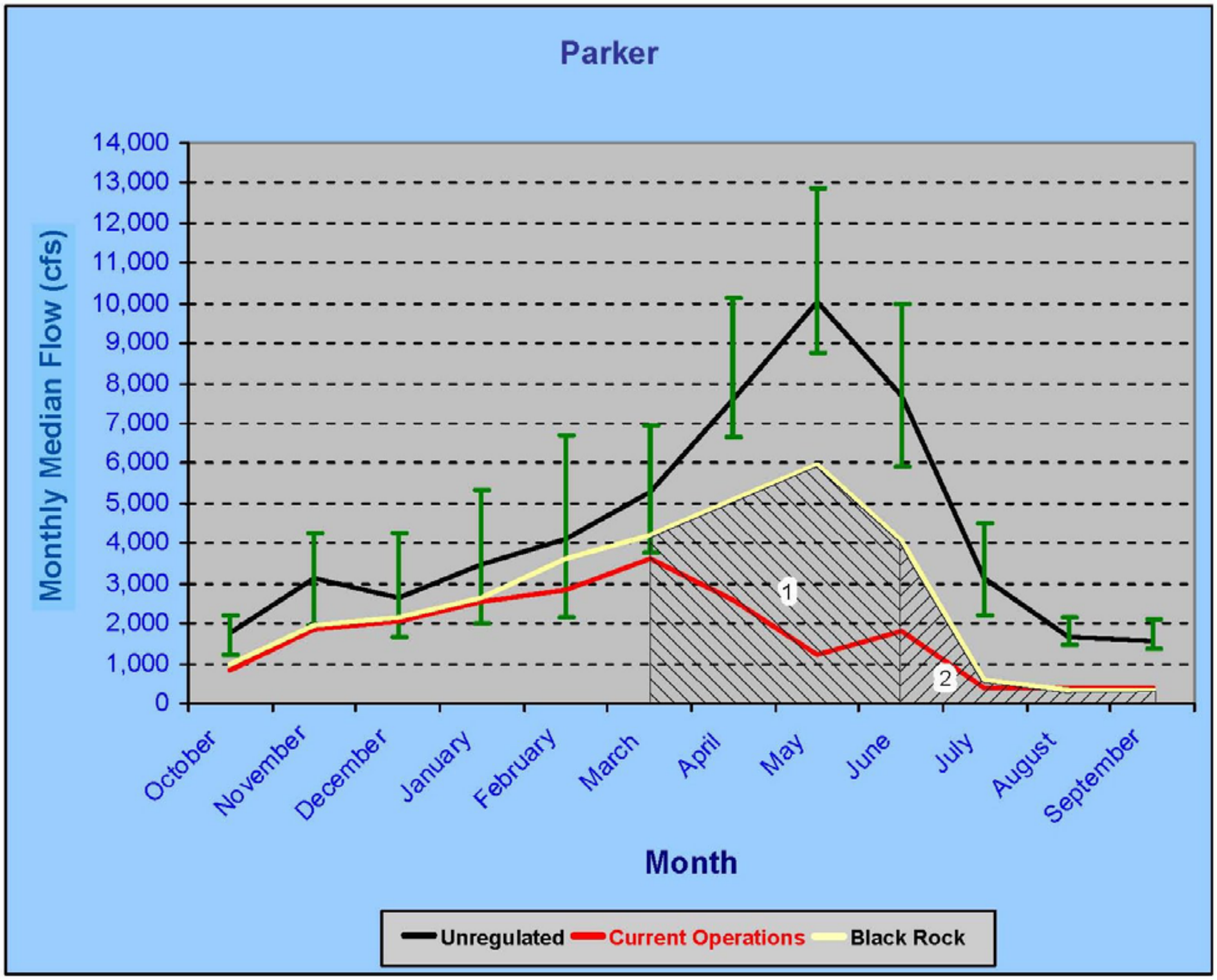


Figure 8-4. Comparison of estimated median monthly Wapato reach flows under the three scenarios (based on the 1981-2003 period of record)

The Wapato reach discussion is prefaced by acknowledging that spring Chinook salmon and steelhead use the mid-Yakima River primarily for winter rearing and smolt outmigration. However, fall Chinook salmon and coho salmon spawn and complete their life cycles within this portion of the Yakima River, and their life stage time periods generally coincide with those of spring Chinook salmon. The following discussion describes the numeric indicators shown on figure 8-4.

1. The Black Rock scenario would positively affect fry colonization and smolt out migration life stages relative to the current operation scenario. The April through June flows would resemble a more natural (unregulated) hydrograph in that monthly flows would more closely follow the natural flow regime. The Black Rock scenario mean May flow of 6,000 cfs would be about 5,000 cfs greater than the current operation scenario in May. The potential for increased spring flows should result in more side channel and backwater habitat, creating nursery areas for emergent fry (fall Chinook salmon and coho salmon). The Wapato reach has some of the best remaining side and backwater channel habitat in the basin, and the potential for increasing these habitat types in the spring would be a great benefit to salmonid

productivity. Smolt outmigrants would benefit through decreased travel time to the Columbia River, reduced predator exposure, and consequently, better smolt-to-smolt survival. The remaining spring Chinook salmon and steelhead life stages under the Black Rock scenario would be comparable to the current operation scenario.

2. Title XII of the Act of October 31, 1994, authorizing the Yakima River Basin Water Enhancement Project, provides for instream flow targets of 300-600 cfs over Sunnyside Diversion Dam during the irrigation season. While the Black Rock scenario would generate 500 cfs, it would be desirable to have an increase in summer flows (July through September) to a range of 1,000-1,200 cfs under the Black Rock scenario to enhance summer rearing habitat, especially for the side and backwater channels. This operation will be considered in future evaluations since the current operation scenario largely dewaters this habitat.

### 8.1.1.6 Naches Reach

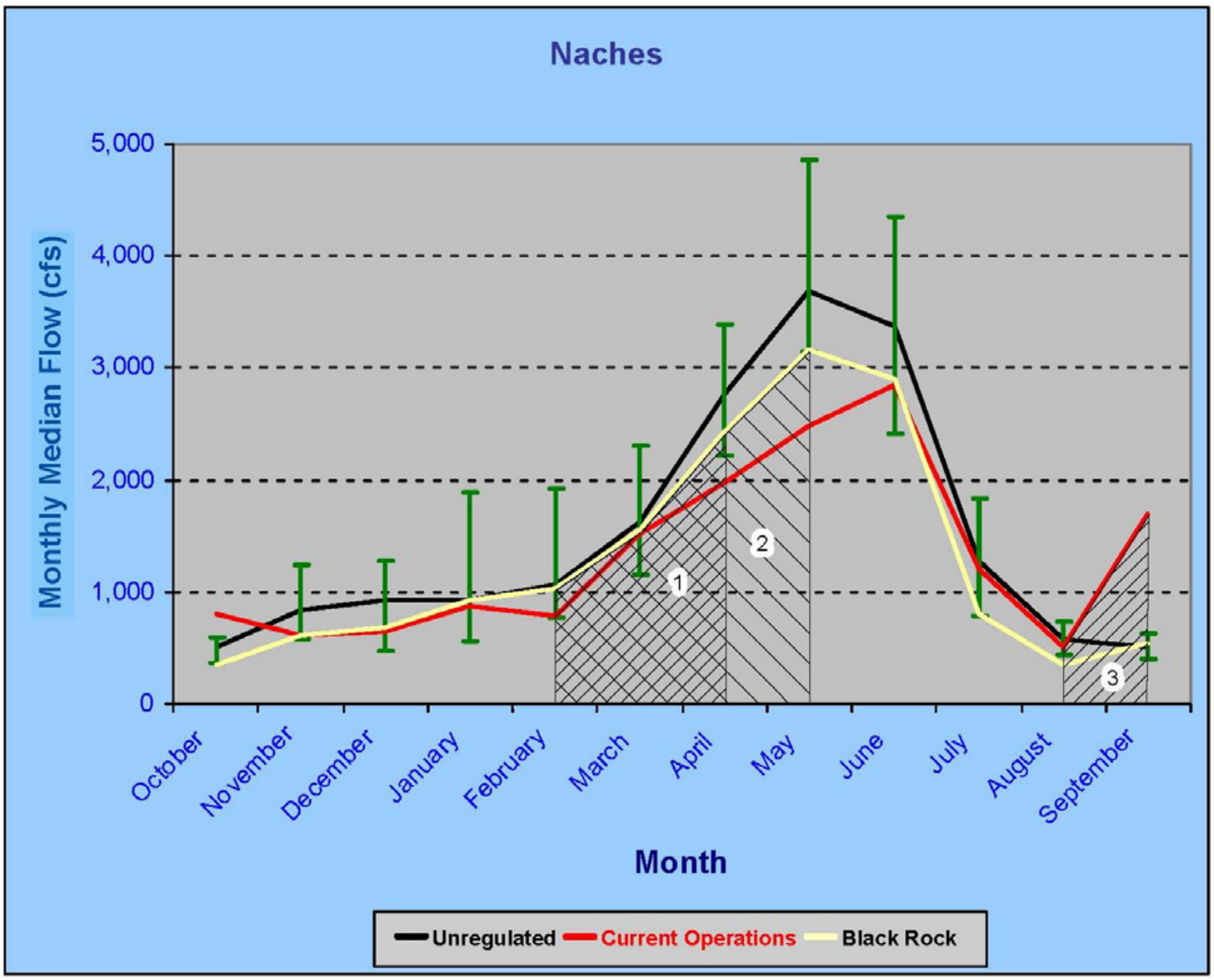


Figure 8-5. Comparison of estimated median monthly Naches reach flows under the three scenarios (based on the 1981-2003 period of record)

The following discussion describes the numeric indicators shown on figure 8-5.

1. The Black Rock scenario would improve flows during the March through April spring Chinook salmon fry colonization period through increased flows and correspondingly greater side and backwater channel habitat for newly emergent fry. Notably, a substantial amount of side and backwater channels is now available in the lower Naches River if adequate flow exists to keep it inundated.

2. Spring March through May flows for smolt outmigration would improve under the Black Rock scenario compared to the current operation scenario. Notably, peak flows would occur in May under the Black Rock scenario, which would coincide with the natural hydrograph and fall within the 25th-75th percentile bounds in all months, except August.

3. The removal of the August through September flip-flop reservoir operation effect would be a major benefit. September spring Chinook salmon spawning flows for the current operation scenario would average 1,700 cfs compared to 514 cfs for the unregulated scenario and 538 cfs for the Black Rock scenario. This would reduce the potential risk of dewatering spring Chinook salmon redds during the initial period of egg incubation for early spawning fish.

Flows in September and October under the Black Rock scenario would resemble a more natural (unregulated) hydrograph than those for the current operation scenario. The elimination of flip-flop reservoir operation would have significant effects from September to October. Biologically, this is a critical period when both juvenile spring Chinook salmon and steelhead initiate downstream movement in the Naches basin seeking outwinter refugia in the lower Naches River and beyond. The potential now exists for disrupting or displacing fish in side channel habitats especially as they seek outwinter rearing habitat. This would not occur with the Black Rock scenario.

The following findings are based solely on preliminary analysis of the hydrographs as related to the unregulated flow scenario.

**Findings:** **Overall across the four stream reaches, the Black Rock scenario would produce a more natural (unregulated) hydrograph than the current operation scenario.**

**The magnitude and timing of spring runoff with the Black Rock scenario would resemble a more natural (unregulated) hydrograph.**

**The current flip-flop reservoir operation could be eliminated or significantly reduced with the Black Rock scenario. High summer flows in the Cle Elum reach resulting from the current operation of transporting irrigation water to the Roza and Sunnyside Divisions would be greatly reduced. High fall flows downstream from Tieton Dam, to meet Sunnyside Division and Wapato Irrigation Project water needs, would also be significantly reduced. This would**

**result in a return of the streamflow regime to a more natural (unregulated) hydrograph.**

## 8.1.2 Irrigation

Another objective of the Storage Study is to increase the water supply available for existing irrigated agriculture use in the Yakima River basin during drought years. The legal and operational framework for Yakima River basin water allocation and management that has emerged through the years established two classifications of irrigation water users, proratable and nonproratable. In a water right relationship, the nonproratables are considered senior and the proratables are junior water right holders. During periods of annual water shortage, the proratable water users are limited to a less than full water supply based upon Reclamation's forecast of the total water supply available for Yakima Project purposes between April 1 and September 30. A specific objective of the Black Rock alternative water exchange is to provide the proratables a water supply of not less than 70 percent of their water allocation in years of proration.

In recent years, the Yakima River basin experienced water shortages in 1987, 1988, 1992, 1993, 1994, and 2001. The severity of shortage, as measured by the percentage of full water supply received by the proratables, ranged from 90 percent in 1988 to 37 percent in 1994 and 2001. In this Assessment, the irrigation water supply goal is to provide not less than 70 percent supply for proratable rights in dry years. This would increase the 1994 and 2001 proratable water supplies by 33 percent (from 37 to 70 percent).

Reclamation's most recent tabulation of irrigation allocation for entities upstream from the Parker gauge for the April through October irrigation season is dated April 29, 1994. Table 8-2 summarizes this tabulation pertinent to proratable water users.

Table 8-2. Proratable water users

| Irrigation Entity | Proratable Acre-Feet Per Year |
|---|---|
| total basin allocation | 1,279,883 |
| potential exchange participants | |
| Roza Division | 375,000 |
| Sunnyside Division | 142,684* |
| Terrace Heights Irrigation District | 1,345* |
| Selah-Moxee Irrigation District | 4,281* |
| Union Gap Irrigation District | 4,642 |
| subtotal | 527,952 |
| net proratable allocation | 751,931 |
| other proratable entities | |
| Wapato Project | 350,000 |
| Kittitas Reclamation District | 336,000 |
| Yakima-Tieton Irrigation District | 34,835 |
| Westside Irrigation Company | 8,200 |
| city of Ellensburg | 6,000 |
| city of Yakima | 6,000 |
| Naches-Selah Irrigation District | 4,486 |
| Yakima Valley Canal Company | 4,305 |
| other entities (8) | 2,096 |
| *Numbers differ from those shown in table 3-2, which incorporates post-1994 changes resulting from the *Acquavella* case. | |

**Findings: Based on the above tabulation, the irrigation benefits of the Black Rock alternative would have two primary parts as follows:**

**1. The five potential exchange participants accepting Columbia River water would receive not less than 70 percent of their proratable supply from that source.**

**2. A portion of the Yakima River water not delivered to the five potential exchange participants would be allocated to other Yakima Project proratable water users so they would receive not less than a 70 percent supply.**

### 8.1.3 Municipal Water Supply

Another objective of the Storage Study is to provide water for current and future municipal water supply use within the Yakima River basin. Under the identified water exchange concept of the Black Rock alternative, a portion of the Yakima River basin irrigation season water supply not diverted could be allocated to municipal water supply.

The most recent quantitative analysis of the Yakima River basin municipal water supply needs is contained in the January 2003 Yakima River Basin watershed plan [18] prepared by the Yakima River Basin Watershed Planning Unit. Table 8-3 summarizes the plan's findings.

Table 8-3. Current and projected municipal demands
(annual demand in acre-feet per year)

| Public Water Systems Serving 1,000 or More Connections | Year | | |
|---|---|---|---|
| | 2000 | 2010 | 2020 |
| basin total (surface and groundwater) | 54,340 | 66,690 | 83,620 |
| basin total (surface water) | | | |
| city of Cle Elum | 897 | 1,054 | 1,169 |
| city of Yakima | 18,609 | 22,932 | 28,119 |
| total | 19,506 | 23,986 | 29,288 |
| percent of basin total | 36 | 34 | 34 |

As table 8-3 indicates, the majority of the municipalities, both as to number and present water use, rely on groundwater. Only the cities of Cle Elum and Yakima currently divert from the Yakima River. Whether this practice would continue into the future depends on State water management policies with respect to issuance of new permits for groundwater appropriation.

Since the municipal water demand, by scale, is less in comparison to irrigation and instream flow use, this Assessment has not addressed the potential effect of the Black Rock alternative on municipal water supply. Future study would consider the needs, benefits, and allocation of water to meet population growth in the Yakima River basin if the Black Rock alternative proceeds to the next phase of the Storage Study.

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# 8.2 Diversion of Columbia River Water

## 8.2.1 Instream Flows

Diversion of Columbia River water with the Black Rock alternative raises the question of reduced Columbia River flow and effects on streamflow and hydroelectric generation. Pumping from Priest Rapids Lake to a Black Rock reservoir would certainly reduce streamflow in the 62-mile reach downstream from Priest Rapids Dam to the Yakima River confluence. However, at the confluence, the historic pattern of Yakima River inflows would increase due to the return of exchange water used in the Yakima Project.

As discussed below, it is not possible at this time to correlate monthly pumping to a Black Rock reservoir and the associated Columbia River depletions with the Yakima River inflow changes projected to occur. Consequently, the information presented in this section is solely related to the results of hydrologic modeling to show the projected changes in Yakima River flows at the Kiona gauge (RM 29.9, near the Yakima-Columbia River confluence) resulting from the Yakima Project's use of exchange water.

## 8.2.2 Hydrologic Models

Presently, the Hyd-Sim model of the FCRPS (used by BPA) and the Yak-RW model (used by Reclamation) do not have comparable time periods of historic hydrologic streamflow. The Hyd-Sim model uses current FCRPS operating requirements and historic Columbia River hydrologic flow conditions for the 50-year period from 1929-1978. The Yak-RW model used in simulating Yakima Project operations has a much shorter 23-year historical period of 1981-2003.

## 8.2.3 Yakima River Inflow Changes

Using the Yak-RW model to simulate current Yakima Project operations, the Yakima River basin annual water supply is grouped into three water supply conditions of wet, average, and dry years as represented by the April 1 total water supply available. The total water supply available is an indicator of the water supply projected to be available to the Yakima Project upstream from the Parker gauge from natural runoff, irrigation return flows, and stored waters for irrigation and instream flow targets during April 1 through September 30 of each year. For purposes of this analysis, wet, average, and dry years are defined as follows:

- wet year: April 1 total water supply available is greater than 3,250,000 acre-feet
- average year: April 1 total water supply available is between 2,250,000 and 3,250,000 acre-feet
- dry year: April 1 total water supply available is less than 2,250,000 acre-feet.

Table 8-4 shows these three water supply conditions, in order of available supply.

Table 8-4. Yakima River basin water supply conditions (1981-2003)

| Water Year Type | Year | April 1 total water supply available (acre-feet) |
|---|---|---|
| Wet | 1997 | 4,531,000 |
| | 1999 | 4,007,000 |
| | 1982 | 3,382,000 |
| | 1983 | 3,351,000 |
| | 2000 | 3,284,000 |
| | 2002 | 3,267,000 |
| | 1984 | 3,253,000 |
| Average | 1996 | 3,232,000 |
| | 1998 | 3,167,000 |
| | 1990 | 3,122,000 |
| | 1991 | 3,038,000 |
| | 1995 | 2,929,000 |
| | 1989 | 2,906,000 |
| | 1985 | 2,767,000 |
| | 2003 | 2,573,000 |
| | 1986 | 2,515,000 |
| | 1981 | 2,502,000 |
| | 1988 | 2,492,000 |
| | 1987 | 2,475,000 |
| Dry | 1993 | 2,161,000 |
| | 1992 | 2,119,000 |
| | 2001 | 1,800,000 |
| | 1994 | 1,800,000 |

Average monthly flows at Kiona gauge were then determined for the respective wet, average, and dry water supply conditions using the Yak-RW model monthly output for two scenarios: current Yakima Project operations and projected Yakima Project operations with the Black Rock alternative water exchange. Current operations reflect the present Yakima Project management for flood control, irrigation, and streamflow operations. Streamflow operations include the flow targets at Sunnyside and Prosser Diversion Dams (as provided by Title XII of the Act of October 31, 1994), as well as flip-flop reservoir operations, and other present instream operations throughout the river system as generally described in the *Interim Comprehensive Basin Operating Plan for the Yakima Project, Washington,* in chapter 5: Current Project Operations/Total Water Supply Available [19].

The Black Rock scenario involves the April through October water exchange with Roza and Sunnyside Divisions. This reflects operation of the Yakima Project according to the following assumed allocation of exchange water: (1) for instream flow purposes in wet and average Yakima River basin water supply years, and (2) for irrigation purposes for all other proratables (see table 8-2) to provide not less than a 70 percent supply in dry years. In dry years, the exchange water supply surplus to irrigation needs would be allocated to instream flows. The instream flow hydrograph mimics, to the extent possible, the natural unregulated flow regime.

Yakima River flows at Kiona gauge are comprised of the following: (1) unregulated natural flows, (2) surface and subsurface return flows accruing primarily from irrigation, and (3) Yakima

Project reservoir operations specifically for streamflow enhancement such as would occur from use of exchange water in mimicking the natural unregulated flow regime.

Figures 8-6, 8-7, and 8-8 show hydrographs of average monthly flows at Kiona gauge for the two scenarios under wet, average, and dry water supply conditions, respectively.

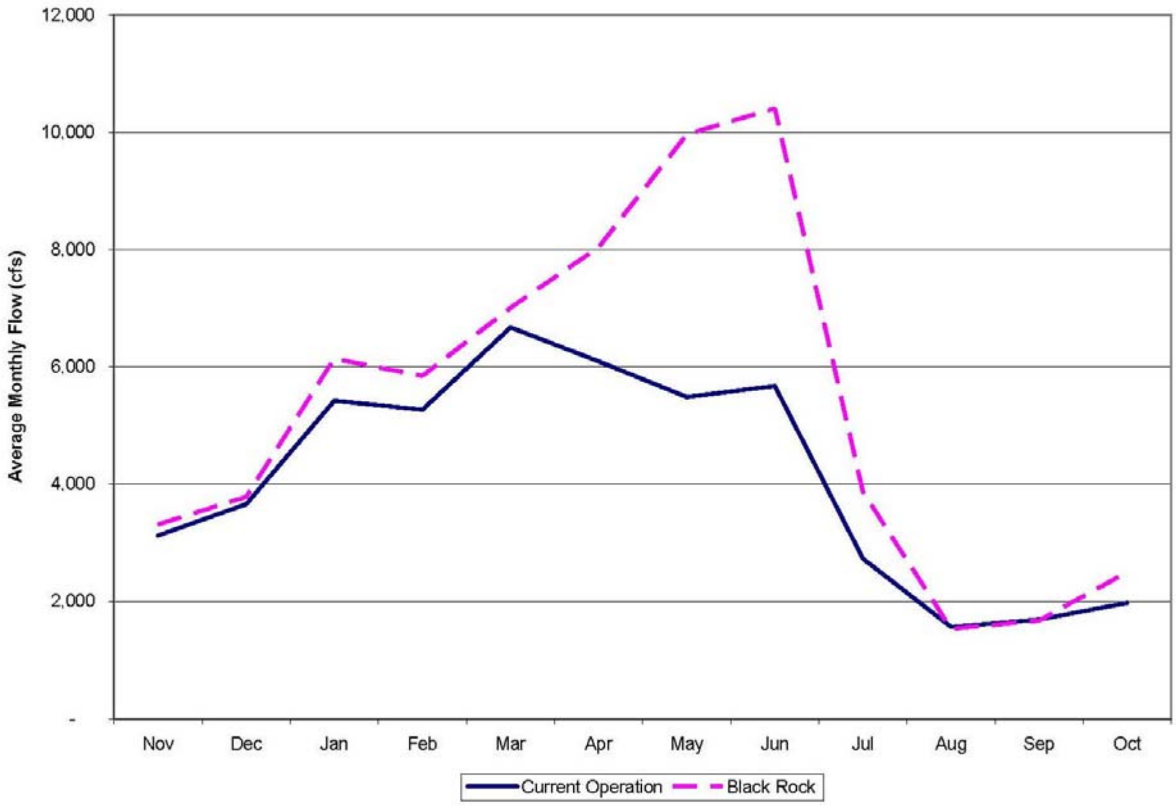


Figure 8-6. Average monthly flows at Kiona gauge under wet water supply conditions

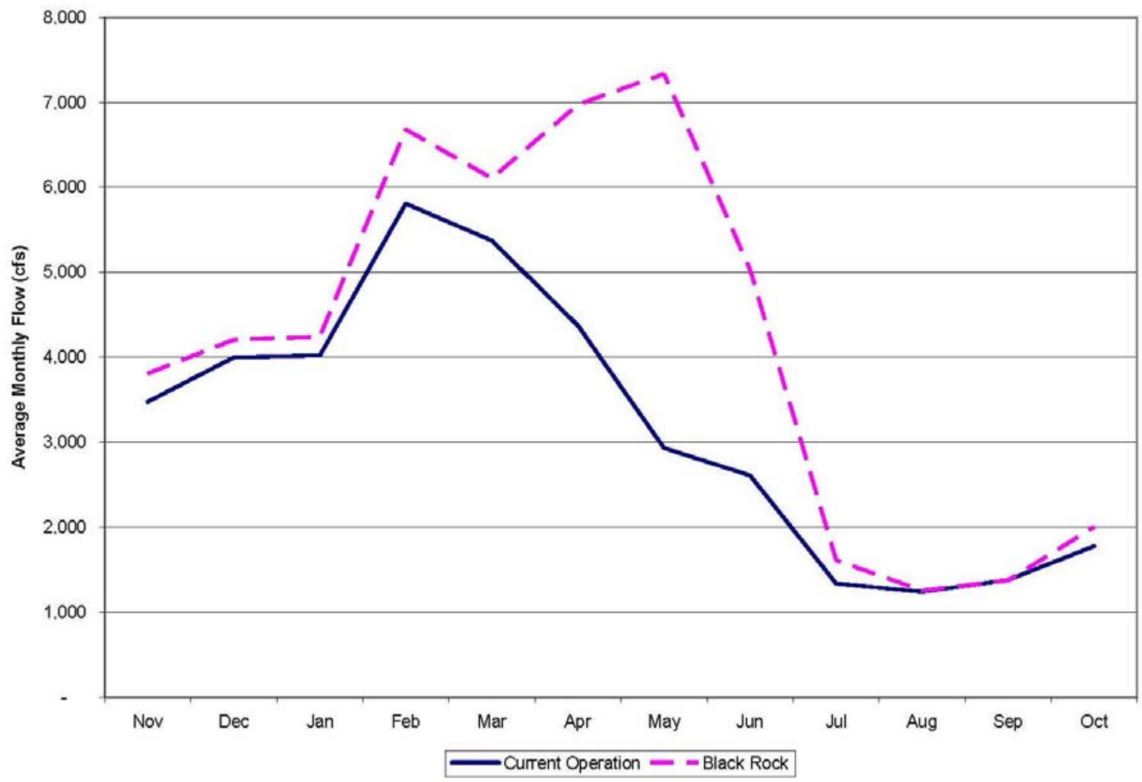


Figure 8-7. Average monthly flows at Kiona gauge under average water supply conditions

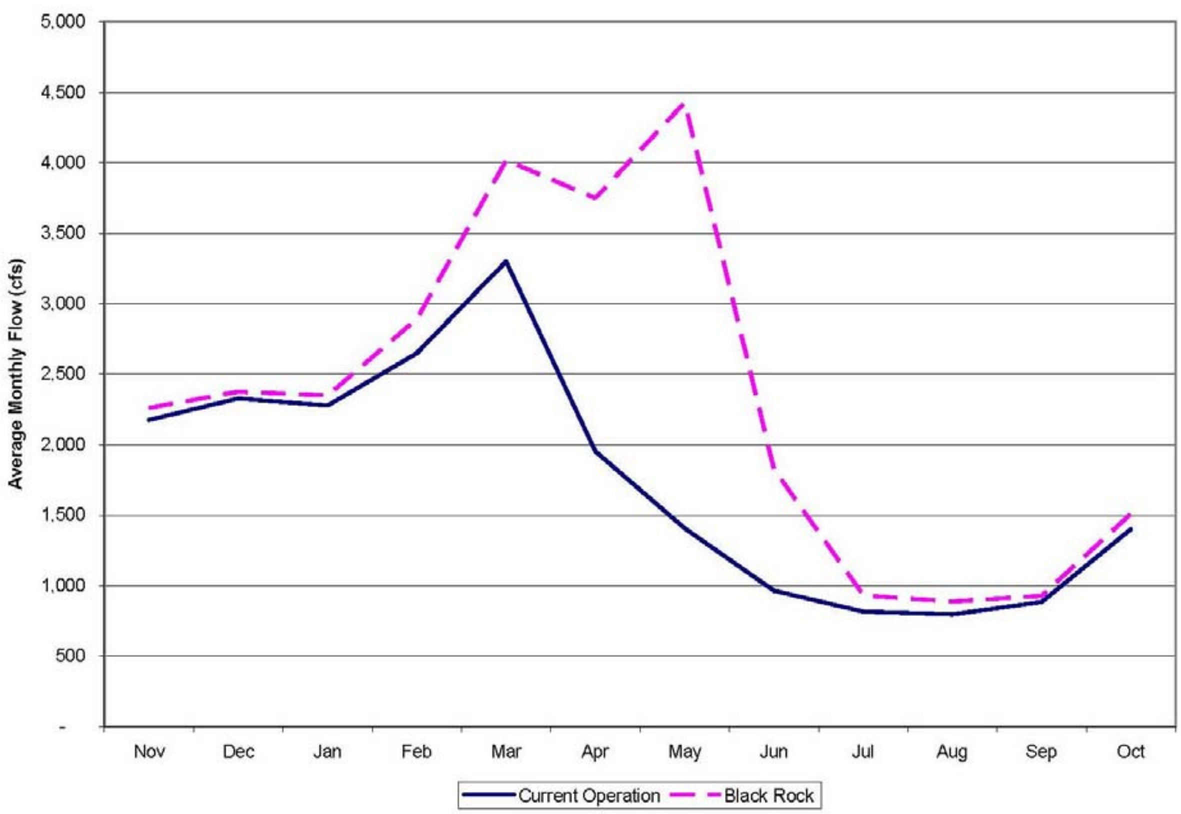


Figure 8-8. Average monthly flows at Kiona gauge under dry water supply conditions

Table 8-5 shows the resulting average monthly flows for wet, average, and dry Yakima River water supply conditions for the two scenarios. Annually, it is projected the additional flow in the Yakima River at its mouth could be 900,000 acre-feet with wet water supply conditions, 700,000 acre-feet with average water supply conditions, and about 400,000 acre-feet with dry water supply conditions.

Table 8-5. Average monthly Yakima River flows at Kiona gauge based on wet, average, and dry Yakima River basin water supply conditions

| | Wet Years | | | Average Years | | | Dry Years | | |
|---|---|---|---|---|---|---|---|---|---|
| Month | Current Operation | Black Rock | Difference | Current Operation | Black Rock | Difference | Current Operation | Black Rock | Difference |
| | (cfs) | | | | | | | | |
| Nov | 3,100 | 3,300 | 200 | 3,500 | 3,800 | 300 | 2,200 | 2,300 | 100 |
| Dec | 3,700 | 3,800 | 100 | 4,000 | 4,200 | 200 | 2,300 | 2,400 | 100 |
| Jan | 5,400 | 6,100 | 700 | 4,000 | 4,200 | 200 | 2,300 | 2,400 | 100 |
| Feb | 5,300 | 5,800 | 500 | 5,800 | 6,700 | 900 | 2,600 | 2,900 | 300 |
| Mar | 6,700 | 7,000 | 300 | 5,400 | 6,100 | 700 | 3,300 | 4,000 | 700 |
| Apr | 6,100 | 8,000 | 1,900 | 4,400 | 7,000 | 2,600 | 2,000 | 3,700 | 1,700 |
| May | 5,500 | 10,000 | 4,500 | 2,900 | 7,300 | 4,400 | 1,400 | 4,400 | 3,000 |
| Jun | 5,700 | 10,400 | 4,700 | 2,600 | 5,000 | 2,400 | 1,000 | 1,800 | 800 |
| Jul | 2,700 | 3,900 | 1,200 | 1,300 | 1,600 | 300 | 800 | 900 | 100 |
| Aug | 1,500 | 1,500 | - - | 1,200 | 1,300 | 100 | 800 | 900 | 100 |
| Sep | 1,700 | 1,700 | - - | 1,400 | 1,400 | - - | 900 | 900 | - - |
| Oct | 2,000 | 2,500 | 500 | 1,800 | 2,000 | 200 | 1,400 | 1,500 | 100 |
| | (acre-feet) | | | | | | | | |
| Annual | 2,900,000 | 3,800,000 | 900,000 | 2,300,000 | 3,000,000 | 700,000 | 1,300,000 | 1,700,000 | 400,000 |

Yakima River flows at Kiona gauge during dry water supply years would be less than in wet and average water supply years due to the following:

- The additional Yakima Project water supply made available as the result of an exchange with Roza and Sunnyside Divisions would be less due to the categories of water rights in the exchange; about 60 percent are proratable rights subject to proration in dry years.
- Part of the available exchange water could be used in dry years to improve the water supply of all Yakima Project proratable rights to not less than 70 percent.[9] This results in the consumptive use of part of the exchange water for irrigation (a portion of this would accrue to the Yakima River as surface and subsurface return flows) while the residual available supply would be used for instream flow purposes.

**Findings: As defined in this Summary Report, wet, average, and dry Yakima River basin water supply conditions over the 23-year period of analysis (1981-2003) have occurred as follows:**

[9] With the exception of the Roza and Sunnyside Divisions which are provided Columbia River water.

| Water Supply Condition | Number of Years | Percentage |
|---|---|---|
| Wet | 7 | 29 |
| Average | 12 | 50 |
| Dry | 4 | 21 |
| Totals | 23 | 100 |

**The Black Rock alternative water exchange would result in increased Yakima River streamflow entering the Columbia River at the Yakima River confluence. Estimated increased streamflow is:**

- **wet Yakima River basin water supply conditions – 900,000 acre-feet**
- **average Yakima River basin water supply conditions – 700,000 acre-feet**
- **dry Yakima River basin water supply conditions – 400,000 acre-feet**

## 8.3 Hydropower Generation and Pumping Energy

The discussion of the mid-Columbia River system is extracted from Grant PUD's relicensing report of 2003 [15].

### 8.3.1 Existing Facilities

The Priest Rapids Project is located on the main stem Columbia River in Central Washington and includes two hydroelectric developments, Wanapum and Priest Rapids, owned and operated by Grant PUD. Each development consists of a dam, powerhouse, fishways, reservoir, 230-kilovolt transmission lines, and ancillary facilities. Wanapum and Priest Rapids powerhouses each have 10 turbine-generators with capacities of 900 MW and 850 MW, respectively, for a presently authorized, installed capacity of 1,750 MW. The maximum hydraulic capacity of each powerhouse is approximately 175,000 cfs assuming all units are operating at full capacity.

The two developments produced a total of 9.65 billion kilowatt-hours of electricity in 2002, which is equivalent to the energy consumed in a year by a city approximately the size of Seattle. Under current power purchase agreements, Grant PUD reserves 36.5 percent of the energy produced for its own use. The remaining 63.5 percent of the generation is provided under long-term contracts, at cost, to 12 Pacific Northwest utilities that collectively serve customers in Washington, Idaho, Oregon, Montana, and Utah.

Priest Rapids development is part of the much larger, seven-dam, mid-Columbia River hydroelectric system of about 14,000 MW, which extends from near the United States/Canada border to the beginning of the Hanford Reach, for a total of 351 miles (see figure 8-9). This includes two Federal facilities, Grand Coulee Dam (Reclamation) with an installed generation capacity of about 6,800 MW and Chief Joseph Dam (U.S. Army, Corps of Engineers) with an installed capacity of about 2,600 MW. Three Washington Public Utility Districts own and operate the five hydroelectric projects downstream from Chief Joseph Dam, having a combined installed generation capacity of about 4,500 MW. Priest Rapids Dam is at the downstream end of this integrated system of hydropower facilities. Table 8-6 provides information on the mid-Columbia River system.

Downstream from the mouth of the Yakima River, Federal powerplants on the lower Columbia River are at McNary, John Day, The Dalles, and Bonneville Dams.

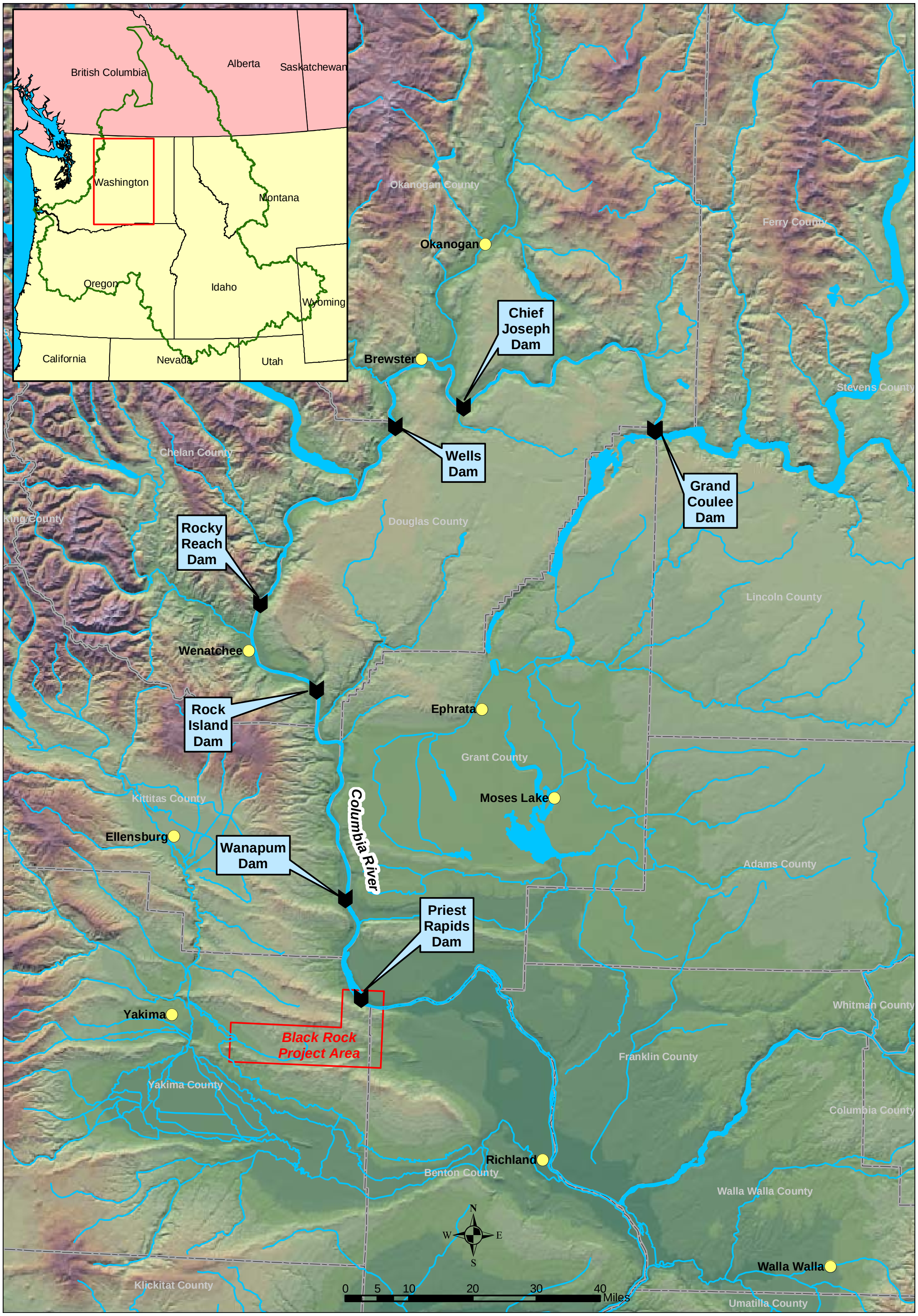


Figure 8-9. Mid-Columbia River hydroelectric system

Table 8-6. Summary of hydroelectric projects in the mid-Columbia River system

| Project | Owner | Location (RM) | Drainage Area ($mi^2$) | Usable Storage[1] (million acre-feet) | Maximum Plant Hydraulic Capacity (cfs) | Installed Capacity (MW) |
|---|---|---|---|---|---|---|
| Grand Coulee | Reclamation | 596.6 | 74,700 | 5.22 | 280,000 | 6,809[2] |
| Chief Joseph | Corps of Engineers | 545.1 | 75,000 | 0.12 | 213,000 | 2,614 |
| Wells[3] | Douglas PUD | 515.8 | 86,100 | 0.10 | 220,000 | 840 |
| Rocky Reach[3] | Chelan PUD | 473.7 | 87,800 | 0.04 | 220,000 | 1,287 |
| Rock Island[3] | Chelan PUD | 453.4 | 89,400 | 0.01 | 220,000 | 660 |
| Wanapum[3] | Grant PUD | 415.8 | 90,900 | 0.16 | 180,000 | 900 |
| Priest Rapids[3] | Grant PUD | 397.1 | 96,000 | 0.04 | 175,000 | 855 |

[1] The volume of water contained within the normal reservoir operating range.
[2] Includes generating capacity of the pump/generator plant.
[3] Data for these private facilities obtained from Grant PUD's relicensing report of 2003 [20].

The seven-dam, mid-Columbia system contains a significant amount of active storage that enhances the reliability and flexibility of the Northwest's entire electric generation system. The usable storage in the mid-Columbia system is primarily at Grand Coulee (Franklin D. Roosevelt Lake) with over 5,200,000 acre-feet, while the six downstream projects account for about 440,000 acre-feet, or about 10 percent. Overall, 86 percent of the annual flow at Priest Rapids Dam is provided by controlled releases from Grand Coulee Dam.

Reclamation requested BPA's assistance in evaluating several power aspects of the Black Rock alternative. These include the following:

- Annual pumping energy required to lift water from Priest Rapids Lake to a Black Rock reservoir, and the estimated annual cost if purchased from the FCRPS
- Annual hydropower generation effects at the Priest Rapids development and at other non-Federal and Federal hydropower facilities
- The financial viability of pump generation at the Black Rock alternative
- Potential impacts relating to the Columbia River Treaty and operating agreements.

BPA used computer-modeling capabilities to analyze operation of the Black Rock alternative and estimate its effects on power production of Federal and non-Federal hydropower projects in the region. This analysis was performed using the Hyd-Sim hydroregulation model simulating current operations imposed on Columbia River streamflows represented by the years 1929 to 1978. Results from this study were then compared with a baseline analysis (excluding the Black Rock alternative) to estimate effects on power production of the existing system with the Black Rock alternative operation.

BPA followed operating criteria where diversion of Columbia River water to a Black Rock reservoir would occur at times when water was available in excess of instream flow targets.

BPA assumed if upstream reservoirs (primarily Franklin D. Roosevelt Lake) were fuller than necessary to meet ESA commitments, those reservoirs would release additional water to meet the pumping demands of the Black Rock alternative. BPA developed information for the following two Black Rock alternative configurations:

- a 1,300,000-acre-foot active reservoir capacity and a 3,500-cfs Columbia River pumping plant
- an 800,000-acre-foot active reservoir capacity and a 6,000-cfs Columbia River pumping plant.

## 8.3.2 Pumping Energy Requirements and Costs

As a part of their work, BPA conducted the Black Rock alternative pumping analysis to determine monthly Columbia River diversions that could be made to a Black Rock reservoir. In the analysis, BPA permitted the release of stored water from upstream reservoirs for pumping to a Black Rock reservoir, if otherwise allowed. This operation resulted in additional water being available for diversion primarily in wet years. (Reclamation did not use this assumption in the water availability assessment [3].) The results indicate a 172-MW average annual amount of energy would be necessary to meet the requirements of the Black Rock alternative with a 1,300,000-acre-foot reservoir. BPA calculated the cost of this power on an average annual basis to be $62 million. Pumping energy cost estimates used 2004 energy price assumptions as forecasted in BPA's August 2003 rate case and could be higher or lower if a new rates analysis were performed due to changes in market conditions. Table 8-7 shows the monthly pumping energy requirements and estimated costs as determined by BPA.

Table 8-7. Preliminary monthly pumping energy requirements to pump to a Black Rock reservoir

| Month | 1,300,000-acre-foot reservoir and 3,500-cfs pumping plant | 800,000-acre-foot reservoir and 6,000-cfs pumping plant |
|---|---|---|
| Energy required to pump to a Black Rock reservoir | | |
| | (average megawatts) | |
| August 1-15 | 205 | 179 |
| August 16-31 | 39 | 41 |
| September | 466 | 607 |
| October | 344 | 372 |
| November | 216 | 36 |
| December | 89 | 0 |
| January | 10 | 0 |
| February | 0 | 0 |
| March | 63 | 59 |
| April 1-15 | 108 | 103 |
| April 16-30 | 76 | 73 |
| May | 209 | 202 |
| June | 210 | 249 |
| July | 239 | 236 |
| Annual average | 172 | 163 |
| Cost of energy required to pump to a Black Rock reservoir | | |
| Range of costs | $23 to $121 million | $22 to $100 million |
| Average annual costs | $62 million | $55 million |

**Findings: Average annual pumping energy required and the average annual cost are estimated at 172 megawatts and $62 million for the large reservoir pump only option and 163 megawatts and $55 million for the small reservoir pump only option.**

## 8.3.3 Effects on Current Hydropower Generation

Hydropower generation effects associated with the Black Rock alternative as assessed by BPA would occur at both non-Federal and Federal hydropower projects of the mid to lower Columbia River. Because the FCRPS is operated as a coordinated system, flow changes as a result of the Black Rock alternative could have minor effects on power generation at other FCRPS hydropower facilities as well.

### 8.3.3.1 Non-Federal Hydropower Projects

Diversion of 3,500 cfs or 6,000 cfs from Priest Rapids Lake for pumping to a Black Rock reservoir would reduce generation at Priest Rapids Powerplant on the average by 4 MW, which is less than 1 percent annually. In the fall months when heavy pumping was taking place, pumping to a Black Rock reservoir may result in a 5 to10 percent loss in hydropower production at Priest Rapids Dam. Power generation impacts at other non-Federal projects would sometimes be positive and sometimes negative. These impacts would be related to the operational assumption of releasing stored water from upstream reservoirs (primarily Franklin D. Roosevelt Lake) for pumping to a Black Rock reservoir. Table 8-8 shows the monthly change in generation at non-Federal Columbia River hydropower projects and the estimated value of the change.

Table 8-8. Preliminary monthly change in non-Federal Columbia River hydropower generation related to operation of the Black Rock alternative

| Month | 1,300,000-acre-foot reservoir and 3,500-cfs pumping plant | | | 800,000-acre-foot reservoir and 6,000-cfs pumping plant | | |
|---|---|---|---|---|---|---|
| | Priest Rapids only | Non-Federal hydro without Priest Rapids | Non-Federal hydro including Priest Rapids | Priest Rapids only | Non-Federal hydro without Priest Rapids | Non-Federal hydro including Priest Rapids |
| | (average megawatts) | | | | | |
| August 1-15 | -1 | 14 | 13 | -1 | 12 | 11 |
| August 16-31 | 0 | -2 | -2 | 0 | 3 | 3 |
| September | -17 | -2 | -19 | -24 | -1 | -25 |
| October | -12 | -5 | -17 | -14 | -4 | -18 |
| November | -1 | 22 | 21 | 0 | 1 | 1 |
| December | -6 | 5 | -1 | -1 | 11 | 10 |
| January | -3 | -18 | -21 | 0 | -8 | -8 |
| February | 0 | -8 | -8 | 0 | -8 | -8 |
| March | -2 | 6 | 4 | -2 | 6 | 4 |
| April 1-15 | -1 | 22 | 21 | -1 | 24 | 23 |
| April 16-30 | 0 | -1 | -1 | 0 | -2 | -2 |
| May | -1 | -7 | -8 | -1 | -6 | -7 |
| June | -1 | -17 | -18 | -2 | -15 | -17 |
| July | -2 | 2 | 0 | -2 | 2 | 0 |
| Annual average | -4 | 0 | -4 | -4 | 0 | -4 |
| Value of generation change at non-Federal Columbia River hydropower projects | | | | | | |
| Range of value | -$3 million to 0 | | -$10 million to $5 million | -$3 million to 0 | | -$11 million to $5 million |
| Average annual value | -$2 million | | -$1 million | -$2 million | | -$1 million |

### 8.3.3.2 Federal Hydropower Projects

Hydropower generation changes would occur at Federal facilities upstream from Priest Rapid Dam and downstream from the Yakima River confluence. With the Black Rock alternative in operation, diversions from Priest Rapids Lake would diminish streamflow in the 62-mile reach from Priest Rapids Dam to the Yakima River confluence, where there are no Federal hydropower facilities. Streamflow depletions from the Black Rock pumping would be somewhat offset by increased flows entering the Columbia River from the Yakima River as the result of use of the exchange water.

The model used to simulate Yakima Project operations with the Black Rock alternative water exchange is based on a 1981-2003 time period, whereas the Columbia River hydrogeneration model reflects a 1929-1978 period. Consequently, Reclamation developed preliminary estimates of Yakima River flows for the 50-year period for BPA's use in analyzing generation changes at Federal hydropower facilities downstream from the Yakima River confluence. On average, the FCRPS would lose approximately 5 MW of annual generation as shown on table 8-9.

Table 8-9. Preliminary monthly change in Federal Columbia River hydropower generation related to operation of the Black Rock alternative

| Month | 1,300,000-acre-foot reservoir and 3,500-cfs pumping plant | 800,000-acre-foot reservoir and 6,000-cfs pumping plant |
|---|---|---|
| | (average megawatts) | |
| August 1-15 | 28 | 24 |
| August 16-31 | 21 | 26 |
| September | -30 | -55 |
| October | -39 | -46 |
| November | 55 | 9 |
| December | -62 | -15 |
| January | -35 | -1 |
| February | -1 | 0 |
| March | 6 | 7 |
| April 1-15 | 8 | 14 |
| April 16-30 | 5 | 3 |
| May | -1 | 3 |
| June | 8 | 10 |
| July | 10 | 9 |
| Annual average | -5 | -4 |
| Value of generation change at Federal Columbia River hydropower projects | | |
| Range of value | -$11 million to $4 million | -$10 million to $4 million |
| Average annual value | -$3 million | -$2 million |

### 8.3.3.3 Combined Regional

Table 8-10 shows the regional combined non-Federal and Federal hydropower generation effects (changes in generation and value of generation changes) related to operation of the Black Rock alternative.

Table 8-10. Preliminary monthly change in regional combined non-Federal and Federal hydropower generation related to operation of the Black Rock alternative

| Month | 1,300,000-acre-foot reservoir and 3,500-cfs pumping plant | 800,000-acre-foot reservoir and 6,000-cfs pumping plant |
|---|---|---|
| | (average megawatts) | |
| August 1-15 | 41 | 35 |
| August 16-31 | 19 | 29 |
| September | -49 | -79 |
| October | -56 | -64 |
| November | 76 | 11 |
| December | -63 | -6 |
| January | -56 | -9 |
| February | -9 | -8 |
| March | 10 | 11 |
| April 1-15 | 29 | 37 |
| April 16-30 | 4 | 2 |
| May | -10 | -4 |
| June | -10 | -6 |
| July | 10 | 9 |
| Annual average | -9 | -8 |
| Value of generation change at regional Columbia River hydropower projects | | |
| Range of value | -$20 million to $9 million | -$20 million to $9 million |
| Average annual value | -$4 million | -$4 million |

**Findings: Both positive and negative monthly changes in regional hydropower generation would result from the Black Rock alternative. The average annual change would be an 8- to 9-megawatt decrease in generation with a $4 million average annual decreased generation value.**

## 8.3.4 Black Rock Alternative Hydropower Generation

There is potential for three hydropower generation facilities as features of the Black Rock alternative. These include an intake pump/generation operation between the Columbia River and Black Rock reservoir, a generation plant at the terminus of the Black Rock outlet facility near Roza Canal, and a generation plant at the Sunnyside Division discharge water delivery pipeline near Sunnyside Canal.

### 8.3.4.1 Intake Pump/Generation

An option considered for the Columbia River intake facilities includes a 3,500-cfs pump/generation option (see section 5.4.1.3). This option was included to compare the estimated cost of a 3,500-cfs pump only and a pump/generation option. The construction cost estimate of the 3,500-cfs pump only option is $190 million less than the cost of a 3,500-cfs pump/generation option. However, no operation studies were conducted to determine how a Black Rock reservoir would fluctuate if stored water were released back to the Columbia River for generation purposes. It is not yet known if a 3,500-cfs pumping plant would be adequate with pump/generation for refilling the reservoir to ensure annual delivery of exchange water in a pump/generation mode. Further, the impact of a pump/generation operation on potential reservoir recreation opportunities has not been identified.

BPA was requested to provide their view on the financial viability of pump/generation under the Black Rock alternative. The closest power market, the mid-Columbia River point of interchange, could be used to value both the power lost to lifting water into a Black Rock reservoir and the subsequent generation of power by releasing water back into Priest Rapids Lake. The latest mid-Columbia River forecast was completed August 2004 to support development of final rates for fiscal year 2005. For the period from October 2004 to September 2006, the average heavy-load hour rate was 19.7 percent higher than the corresponding light-load hour rate.

This trend of narrow differentials is expected to persist into the future with falling (or at least steady) heavy-load hour – light-load hour differentials. Gas fired resources are generally on the margin in determining electricity prices in the Northwest. As replacement power projects come on line and older units are retired, the efficiency differential between the most efficient and the least efficient unit has shrunk. As a consequence, the differential between heavy-load hour and light-load hour prices has also dropped.

Assuming a pumping efficiency of 85 percent and a pump/generation efficiency of 92 percent, for every 1 MW used to pump water into a Black Rock reservoir, 0.78 MW of generation potential would be created. Therefore, to break even simply on an opportunity cost basis, there would need to be a heavy-load hour premium of 28 percent over light-load hour prices. Even though this hurdle rate makes no assumptions about potential head losses that would increase the required heavy-load hour price premium, an examination of the electricity price projections on a month-by-month basis shows few opportunities when pumping would meet this economic test (only 4 of the 24 months in the period were examined). These opportunities would be further limited by nonpower constraints on the FCRPS and the needs of the Black Rock alternative to refill the reservoir during those periods, leaving few, if any, economic pumping opportunities.

BPA did not have estimates for the incremental fixed costs of installing specialized pump generators and other alternative equipment to evaluate the return on investment from such capital expenditures. However, at this time, because the above returns are either negative or zero (based on the foregoing assumptions), pump generation appears financially not viable.

The matter of pump/generation was also discussed with Grant PUD. Grant PUD indicated it is doubtful that investing in pump/generation solely for the purpose of providing load factoring would be economical. It is possible, however, if pump/generation were developed with dynamic capability that was available at all times, there may be opportunities to partner with the Northwest's growing wind industry which has a great need for dynamic shaping services.

#### 8.3.4.2 Generation at Points of Water Discharge

The Black Rock alternative facilities would include a generation plant at the terminus of the Black Rock outlet facility at Roza Canal MP 22.6, and a generation plant at the discharge of the Sunnyside Division water delivery pipeline at Sunnyside Canal. The powerplants would operate only during April through October when water was being delivered to the exchange participants for irrigation purposes. There are two options for each powerplant depending on the water delivery system selected. Section 5.7.3 describes these options. Table 8-11 shows the combination of options and the estimated annual kilowatt-hours (kWh) of energy produced.

Table 8-11. Preliminary new powerplants at points of water discharge

| | Black Rock powerplant | Sunnyside powerplant (canal delivery option) | Total |
|---|---|---|---|
| Appraisal-level water delivery plans that discharge all water into Roza Canal | | | |
| Design discharge | 1,500 cfs | 900 cfs | -- |
| Design head | 338 feet | 221 feet | -- |
| Output at design head | 38 MW | 15 MW | 53 MW |
| Annual energy produced | 180 million kWh | 71 million kWh | 251 million kWh |
| Appraisal-level water delivery plans that connect Sunnyside delivery system to a Black Rock outlet facility bifurcation works | | | |
| Design discharge | 900 cfs | 900 cfs | -- |
| Design head | 338 feet | 435 feet | -- |
| Output at design head | 23 MW | 29.5 MW | 52.5 MW |
| Annual energy produced | 109 million kWh | 140 million kWh | 249 million kWh |

For illustration purposes, the existing 11.25-MW Roza Powerplant operates year-round except when the powerplant is off line due to subordination of hydropower diversions for instream flow maintenance, icing conditions in Roza Canal that preclude delivery of water to the powerplant, or major maintenance. Average annual energy produced at Roza Powerplant over a recent 10-year period would be about 64 million kWh. This compares to a combined output of about 250 million kWh for these two new powerplants.

**Findings: New hydropower facilities at the discharge of Columbia River water into Roza and Sunnyside Canals would provide about 53 megawatts of new generation capacity.**

#### 8.3.4.3 Transmission Facilities

The Black Rock alternative would be interconnected to the existing power transmission system in the area. This would require new facilities as well as the expansion and reinforcement of the surrounding transmission system that would serve the additional power load.

BPA has developed technical requirements for interconnecting lines and loads to ensure the safe operation, integrity, and reliability of the transmission system.[10] These technical requirements include performing technical studies such as power flow, voltage stability, and transient stability. These technical requirements would need to be completed prior to the interconnection of the Black Rock alternative. Until these studies are completed, the extent of the system expansion and reinforcement is unknown.

### 8.3.5 Columbia River Treaty and Operating Agreement Impacts

At this time, it is difficult to assess how the Black Rock alternative would impact the Columbia River Treaty (Treaty) and other arrangements because these agreements are complex, the demands being placed on the multi-purpose river system are changing, and the Black Rock alternative has undefined elements. There are, however, two particular issues that could potentially arise.

1. While operation of the Black Rock alternative itself would be an irrigation depletion that, to a large extent, returns to the Columbia River via Yakima River flow, initial filling of the inactive storage space in Black Rock reservoir would remove water from the Columbia River system. This would represent not only an additional one time impact to the other uses of the system (particularly flows for nonpower purposes and power production), but could also create issues for implementation of Treaty flows and the Pacific Northwest Coordination Agreement. The magnitude of these issues is unclear at this time.

2. The operational impacts of the Black Rock alternative could not be translated into Treaty studies for a considerable period because of the lag associated with collecting actual data and the modeling process dictated by Treaty requirements. The Columbia River Treaty Assured

[10] Technical requirements are identified in BPA's document DOE/BP-3183 which can be accessed at http://www.transmission.bpa.gov/PlanProj/LineLoadCon.pdf

Operating Plan is created 6 years in advance. These studies are informed by inputs on irrigation depletions, irrigation returns, and river flows based on collection of actual data once every 10 years. The Black Rock alternative would affect these assumptions (for example, the flow forecast at The Dalles Dam would likely be impacted to some degree by issues such as evaporation at the new reservoir), and it would take several years of Black Rock operation for these effects to appear in the actual data. Because of this lag, the actual effects of the Black Rock alternative on Treaty operations might not be fully reflected in the determination of Treaty benefits and optimization for 15 to 20 years. At this stage, it is difficult to surmise whether this lag would create issues for either the United States or Canada, or whether there would be remedies available to an impacted party.

# 8.4 Columbia River Fish and Wildlife Issues

## 8.4.1 Existing Fishery Resources

Fisheries information extracted from Grant PUD relicensing application [20] provides the basis for information contained in this section. The fish community in the vicinity of Priest Rapids Dam is composed of more than 40 species, including individuals from 14 of the 24 recognized families of North American freshwater fisheries. Among these species are both resident and anadromous fisheries, including two anadromous salmonid populations listed as endangered under ESA (spring Chinook salmon and summer steelhead) and one resident salmonid (bull trout) listed as threatened.

### 8.4.1.1 Anadromous Fish

Six anadromous fish species are known to inhabit or migrate through the Priest Rapids Dam area. Four of these species are classified as anadromous salmonids, including spring, summer, and fall Chinook salmon, summer steelhead, coho salmon, and sockeye salmon. Of these, only fall Chinook salmon are known to both spawn and actively rear within the area. Spring and summer Chinook salmon, steelhead, coho, and sockeye salmon migrate through the area as adults returning to upriver spawning areas, while smolts travel through on their downstream migration. Pacific lamprey follow migratory patterns similar to those of the anadromous salmonids. American shad is an introduced species that is currently restricted to the Columbia River downstream from Priest Rapids Dam because they do not use the submerged openings into the Priest Rapids fishways. With the exception of American shad, the species listed above are considered endemic to the Columbia River and culturally, economically, and commercially important.

Anadromous salmonid adults migrate through this area from April through November, although steelhead may overwinter in the area and show some movement during winter and early spring. Juvenile salmon and steelhead move through during spring and summer months, with most migrating downstream during the April through June time period. The migration of fall and summer Chinook salmon is typically later in the summer, with yearling Chinook salmon moving during the June through August time period.

The most abundant anadromous fish has been sockeye salmon, with returns averaging about 60,000 per year for the 42-year record of Priest Rapids Dam counts (1960-2002). Average returns of steelhead, and spring, summer, and fall Chinook salmon are somewhat similar, with abundance for these runs averaging 10,000 to 20,000 fish per year. Average abundance of Pacific lamprey is particularly difficult to determine, but appears to be the lowest level of anadromous fish returning to the mid-Columbia River.

A large population of fall Chinook salmon spawns in the Hanford Reach of the Columbia River downstream from Priest Rapids Dam.[11] The abundance of this stock has been increasing in recent years and is considered one of the healthiest inland stocks of Chinook salmon in the Pacific Northwest. From 1964 to 1982, the average escapement of fall Chinook salmon to the Hanford Reach was about 25,000; whereas from 1983 to 1996, the average escapement nearly doubled to about 50,000. From 1983 to present, the Vernita Bar Agreement provided stable spawning flows and ensured that minimum flows would keep a very high percentage of the redds covered through emergence. At about the same time, the original Priest Rapids spawning channel was converted to a conventional hatchery that releases nearly eight million high-quality fall Chinook salmon smolts annually. Many of these hatchery fish are known to spawn in the wild upon return, as the hatchery is immediately adjacent to one of the largest spawning areas at Vernita Bar.

### 8.4.1.2 Resident Fish

Although salmon and steelhead are widely regarded as the most important species in the Pacific Northwest, there is a growing interest among sport fishermen in the fish species that live their entire lives in freshwater. Resident fish in the vicinity of Priest Rapids Dam are a diverse mix of species native to the Columbia River and a variety of game and nongame species that were either accidentally or intentionally introduced to the Columbia River or its subbasins.

Resident fish species are important for a variety of reasons. Game fishes, such as walleye and smallmouth bass, support a recreational fishery. A large number of nongame fishes have importance in the Columbia River's ecology and food web and may be indicator species that demonstrate the basic condition of the river ecosystem. Northern pikeminnow, walleye, and smallmouth bass are known to negatively impact anadromous salmonids through predation on smolts.

A total of 38 resident fish species are known to occur in the Priest Rapids Dam area. These include native game fish, with rainbow trout and mountain whitefish being the most common; native nongame fishes such as the northern pikeminnow; introduced game fishes such as smallmouth mouth bass and walleye; and introduced nongame fishes.

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[11] Adult Chinook salmon returning to pass Priest Rapids Dam from August 14 through November 15 are classified as fall Chinook salmon.

## 8.4.2 Wildlife and Habitat Resources

If the Black Rock alternative proceeds to the next phase of the Storage Study, Reclamation would initiate wildlife and habitat resource inventories in the Black Rock area and would include specific resources that potentially could be affected by the Black Rock alternative, such as:

- the sage grouse, which the U.S. Fish and Wildlife Service is considering listing as threatened under ESA
- the Hanford National Monument area and its proximity to the Black Rock site.

## 8.4.3 Fish and Wildlife Issues and Data Needs

Reclamation initiated studies to address fish and wildlife resource issues associated with alternatives that may result from the Storage Study. One such study originated from a request to the Washington Department of Fish and Wildlife (WDFW) to identify fish and wildlife issues the Storage Study should address. WDFW responded with a 45-item list.

Reclamation next initiated a process for reviewing, screening, and refining the WDFW list. The intended result was to identify significant issues that would serve as the foundation for fish and wildlife analyses and impact assessment. To guide this process, Reclamation defined a fish or wildlife issue as significant if the resource response: (1) is anticipated to be measurable (i.e., either a positive or negative change from existing conditions) and (2) could be linked to more or less water in the Columbia or Yakima River systems resulting from implementation of some aspects of the Storage Study.

The basic approach was to identify and define significant issues involved using the knowledge and expertise of the Biology Technical Work Group (Work Group) in a collaborative workshop environment. The Work Group consists of technical representatives from NOAA Fisheries, U.S. Fish and Wildlife Service, WDFW, Ecology, the Yakama Nation, Yakima Basin Joint Board, Yakima Sub-Basin Fish and Wildlife Planning, and Reclamation's Upper Columbia Area Office (UCAO) and Technical Service Center. The goals of the workshops were:

- to identify and define significant fish and wildlife resource issues that may be associated with developing Black Rock reservoir, Bumping Lake enlargement, Wymer reservoir, Keechelus to Kachess pipeline, (these are all Storage Study alternatives) or some combination of the identified features that result in additional water storage.
- to identify for significant resource issues those questions: (a) for which there is adequate information for proper analysis and existing basic technical data references, and (b) requiring additional information before proceeding with proper analysis.

The Work Group met for two half-day workshop sessions (in March and April 2004) at Reclamation's UCAO in Yakima, Washington. Workshop participants received material initially developed by the WDFW and other information. During the workshops, key points were captured on flip charts and as notes on copies of the WDFW materials. Various project maps and charts were available for reference material. The process was basically an expert workshop approach where members of the Work Group discussed topics of concern and used their expertise to identify and define issues that should be addressed in the Storage Study.

The Work Group transformed the 45-item list into 16 significant fish and wildlife issues, 7 of which would be associated with the Columbia River water exchange. Nine Yakima River basin issues would be associated with changes in Yakima Project operations due to use of the freed-up water realized from the water exchange or from additional inbasin storage. These 9 issues in the Yakima River basin would be affected by other Storage Study options, as well as by the Black Rock alternative, and are, therefore, not discussed in this Summary Report. This issues list likely would change as the Storage Study progressed, additional discussions occurred, and new information developed. Six of the 16 fish and wildlife issues relevant to the potential pumping of Columbia River water from Priest Rapids Lake and storage in a Black Rock reservoir are:

- How would withdrawal of water from Priest Rapids Lake affect water temperature and water chemistry parameters, and how far would such effects extend within Priest Rapids Lake and downstream?
- How would withdrawal of water from Priest Rapids Lake affect anadromous fish spawning and rearing habitat, fry and juvenile stranding, and passage and migration?
- How would withdrawal of water from Priest Rapids Lake affect resident fish spawning and rearing habitat?
- How would withdrawal of water from Priest Rapids Lake affect fish mortality at the intake site?
- How would Black Rock reservoir seepage and groundwater affect the movement of contaminated groundwater at the Hanford Site into the Columbia and lower Yakima Rivers?
- How would construction and the presence of a Black Rock reservoir affect the loss of shrub-steppe habitats, the potential for isolation of local wildlife populations, and disruption of movement corridors?

An issue related to the Yakima River basin would be the use of the stored Black Rock reservoir water by potential water exchange participants. This issue is associated with the substitution of Columbia River water for irrigation purposes in exchange for some current Yakima River diversions.

- How would storage and delivery of Black Rock reservoir water to the lower Yakima River basin affect false attraction of Columbia River anadromous salmonids into Yakima River locations?

The workshops also produced several recommendations concerning the data necessary to assess resource issues. Major data requirements for issues associated with the Columbia River and a Black Rock reservoir include:

- Current monthly hydrology data for Priest Rapids Lake and the Hanford Reach of the Columbia River are needed and likely exist. These data should be compared to projected hydrographs resulting from pumping scenarios for a Black Rock reservoir and incorporated into additional modeling.

- A detailed water quality assessment, including temperature analyses, of Priest Rapids Lake and the Hanford Reach under current and future conditions is needed. Again, current information likely exists, but some additional modeling may be required to characterize future conditions.

A water quality study would first require a determination of the zone of influence within Priest Rapids Lake and perhaps downstream that would be affected under various pumping scenarios.

- Information is needed on the water quality characteristics of the groundwater underlying the Hanford Site and whether there are any contaminants of concern. An assessment of the volume of water that would be lost by leakage from a Black Rock reservoir is needed and estimates of how, or if, this could affect movement of groundwater and the possibility of increased loading in the Columbia and Yakima Rivers. Well data are available, but additional modeling may be required.

The *Defining Fish and Wildlife Resource Issues for the Yakima River Basin Water Storage Feasibility Study,* August 2004, report [21] more fully describes the above Storage Study activities. It briefly discusses these requirements and presents details of the issues, data requirements, and potential approaches to various analyses.

In conclusion, the initial steps have been accomplished to identify and define significant fish and wildlife issues and data needed to assess these issues. A list of fish and wildlife issues has been identified with the assistance of the WDFW, their initial listing of concerns associated with the Black Rock alternative, and the efforts of the Work Group. Reclamation must determine the extent of additional data collection and modeling effort required to address the issues and provide direction for assessment.

**Findings: Six significant fish and wildlife issues in the vicinity of a identified Priest Rapids Lake diversion and Black Rock reservoir area have been identified. A seventh issue relates to the concern that Columbia River water used to irrigate water exchange participants' lands could enter the Yakima River as surface and subsurface return flows, which might result in false attraction of Columbia River salmonids into the Yakima River.**

# 8.5 Cultural Resources

## 8.5.1 Cultural Context

The cultural context of the potential Black Rock site is not well documented. Based on adjacent locales with a legacy of systematic historical and archeological investigations, the Black Rock Valley would likely share a rich cultural heritage with its neighboring regions. Ethnographically, the expanse of the Columbia River above its juncture with the Snake River and the hinterlands adjacent to the river on either side, was home to speakers of the Echeesh-Keen language (formerly known as Sahaptin). Today, these people refer to themselves as Echeesh-Keen Sinwit, although to nonnative people, they are known as the Yakama.

The legally recognized Yakama Nation consists of 14 tribes and bands who were combined socially and politically following the Walla Walla Treaty of June 9, 1855. The 1855 Treaty ceded lands are affected by a potential Black Rock reservoir. The Yakama Nation governing Tribal Council, located at the Yakama Nation Reservation headquarters at Toppenish, speaks for and manages the interests of the constituent 14 tribes and bands.

To understand the cultural heritage of the Black Rock area, it is important to learn about the Wanapum, one of the 14 bands and tribes. The Black Rock reservoir area ceded lands are the home territory of the Wanapum band. Historically, Wanapum shared a language, fisheries, lifestyle, resource procurement strategies, and relatives with nearby Yakama peoples. Although the Wanapum band has been successful asserting a separate identity, they do not have Federal recognition as a tribe. Most Wanapum are enrolled Yakama, while others are enrolled in other tribes. The trust relationship between the Wanapum and the Federal government is indirect and through the membership Wanapum individuals have in federally recognized tribes.

No systematic archeological surveys have been conducted in the Black Rock Valley; therefore, no definitive statements regarding expectations about cultural resources can be made at this time. The Army Training Center, in an environment and landscape analogous to the Black Rock Valley north of Yakima Ridge, has undergone various levels of cultural resource surveys and test excavations over the past 20 years. Archeological research has been intensive the past few years on the Columbia River as a requirement for the Grant PUD's relicensing of the Wanapum and Priest Rapids hydroelectric projects. Further systematic archeological research has occurred immediately downstream on the Department of Energy's Hanford Site. This research reveals that a diversity of site types, as well as sites of great antiquity, are present in the region. A presumption for a similar archeological record can be made for the Black Rock Valley.

Lands in the Black Rock site are currently in private ownership but have been used in the past by native peoples. Systematic research and cultural resource surveys of the alternative area are needed to identify such use.

### 8.5.2 Managing Cultural and Historic Resources

Because the cultural context of the potential Black Rock site is not well documented, investigations and studies to identify, evaluate, and manage cultural and historical resources would be conducted if the Black Rock alternative proceeds to the next phase of the Storage Study.

The size of the potential storage facility and associated impacts, the relationship of the Black Rock site to the Columbia River and Indian ceded lands, the Holocene geomorphology, and the high site density in nearby locales are indicators of a high level of complexity in the cultural and historic resources. In addition, these factors predispose the Black Rock alternative to a high level of interest and scrutiny from Indian tribes, State and Federal partners and reviewers, the professional historic preservation community, and the public.

Further investigations and studies could include the following:

- Class I survey, which is preparation of a historic resources and ethnographic overview
- Class III survey, which is a field survey to identify sites and traditional cultural properties
- Evaluate those sites or properties for eligibility to the National Register of Historic Places
- Develop mitigation measures at eligible properties that cannot be avoided by alternative actions
- Post-project site management, interpretation, and stewardship.

The sequence of study activities would most likely be scheduled as follows:

1. Conduct the Class I overview survey, Class III field reconnaissance, and the traditional cultural properties inventory as a single activity.
2. Conduct investigations at selected historic properties (based on the Class III survey) for their eligibility to the National Register.
3. Conduct data recovery operations at those properties determined eligible for the National Register but that cannot be avoided by construction and operation activities.

One objective of the above work would be to identify the cultural resource and ethnographic information necessary for input into the environmental impact statement phase of the Storage Study.

**Findings: The Black Rock Valley area is likely to have a rich cultural heritage similar to its neighboring regions. Extensive investigations are necessary to identify and evaluate cultural resources.**

## 8.6 Recreation

The Yakima River basin currently provides a wide variety of water-based recreation activities enjoyed by local and regional residents. The Black Rock alternative could enhance these activities by providing increased streamflows, higher reservoir elevations at existing reservoirs, and new reservoir storage. Each of these effects could vary as to recreational benefits depending on Reclamation's operational procedures for Yakima Project.

The Storage Study has not progressed to the point of evaluating recreational benefits associated with the Black Rock alternative. Initial discussions have taken place among Reclamation staff and representatives of Washington State agencies involved in recreation programs. There is agreement that data collection and studies are needed, particularly with respect to existing and future demand for flat-water related recreation activities in the Yakima River basin. State agencies have agreed to participate in these activities if the Black Rock alternative proceeds to the next phase of the Storage Study.

**Findings: A Black Rock reservoir could create flat-water recreation opportunities resulting in monetary benefits to the local and regional economies. The extent to which recreational use of the reservoir might be a substitution for, or a displacement of, other regional recreation sites must be assessed.**